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Estimating the Severity of Intellectual Disability in Adults: A Mokken Scaling Analysis of the Learning Disability Screening Questionnaire

Aja L. Murray and Karen McKenzie

Abstract

A Mokken scaling analysis of the Learning Disability Screening Questionnaire (LDSQ) suggested that, with the exception of 1 item, the scale conforms to the properties of a Mokken scale. This has advantages for estimating the severity of intellectual disability and inferring the difficulties likely to be experienced by an individual for whom there is incomplete information on intellectual and adaptive functioning.

Keywords: intellectual disability, severity, Mokken scaling, Learning Disability Screening Questionnaire

The diagnosis of intellectual disability (known within the United Kingdom as learning disability) requires that an individual meets three criteria: significant impairment of intellectual functioning (an IQ of less than 70), significant impairment of adaptive functioning, and onset before adulthood (American Psychiatric Association [APA], 2000; British Psychological Society [BPS], 2000). As such, the measurement of intellectual functioning is a requirement but not sufficient on its own for diagnosis. A diagnosis of intellectual disability can provide access to a range of benefits for the individual and his or her family, including in terms of practical and financial support. In some countries, it can also influence an individual's journey through the criminal justice system (Talbot, 2010) and, in extreme cases, whether a criminal is sentenced to death (Flynn, 2006). More negatively, the diagnosis can be associated with stigma and low self-esteem (Paterson, McKenzie, & Lindsay, 2012). Consequently, it is important that diagnosis is accurate.

Much research has, therefore, rightfully focused on evaluating and improving the accuracy of intellectual disability diagnosis. This includes the evaluation of psychometric tests used to estimate intellectual or adaptive functioning in intellectually impaired individuals (e.g., de Bildt, Sytema, Kraijer, & Minderaa, 2005; Whitaker, 2010), the development and validation of intellectual disability screening tools (e.g., McKenzie & Paxton, 2006; McKenzie, Paxton, Murray, Milanesi, & Murray, 2012), and considerations of the theoretical basis of the intellectual disability construct (Wehmeyer et al., 2008). This research has occurred in a context where there has been a move away from categorical conceptions of intellectual disability based primarily on the results of intellectual assessments to a focus on level of intellectual disability as indicating the potential support needs of the individual (BPS, 2000). This reflects the heterogeneous nature of those who fall within the

diagnostic category of intellectual disability and the fact that they can vary markedly in levels of adaptive and intellectual functioning. These variations in intellectual disability severity are important and have correlates in health (e.g., Prasher, 2003), psychological well-being (e.g., see Paterson et al., 2012), and care needs. More severe impairments are associated with reduced life expectancy (Bittles et al., 2002), increased likelihood of displaying challenging behaviors (Kiernan & Qureshi, 1993), epilepsy (McGrother et al., 2006), reduced likelihood of social interaction and engagement (see Mansell, 2011), and reduced ability and opportunity to make choices (Smyth & Bell, 2006). There is, therefore, strong impetus for not only achieving accurate diagnoses of intellectual disability but, in addition, finding ways to reliably and validly quantify the severity of difficulties likely to be experienced by someone who has received an intellectual disability diagnosis.

The severity of intellectual disability can be classified in a number of ways. Both the International Classification of Diseases (10th rev.; World Health Organization, 1996) and Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.; APA, 2000) outline the categories of mild, moderate, severe, and profound based on full scale IQ (FSIQ). In the United Kingdom, the recommended categories are severe intellectual disability for a severe impairment in adaptive functioning (i.e., extensive and pervasive support and a FSIQ of under 55), whereas significant intellectual disability represents a significant impairment of adaptive functioning (i.e., the person requires intermittent and limited support and has a FSIQ of between 55 and 69; BPS, 2000). One issue with this system of classification, however, is that the estimation of FSIQ in the intellectual disability range is associated with high levels of uncertainty. For example, Whitaker (2010) has argued that estimates of FSIQ in the intellectual disability range derived from the Wechsler Intelligence Scales for Children—

Fourth Edition (Wechsler, 2003) can be considered accurate only within an interval that extends 16 points below the measured IQ and 25 points above it. Further, although the BPS classification system takes account of the individual's level of adaptive functioning, adaptive functioning and FSIQ are not perfectly correlated (e.g., Moss & Hogg, 1997). This means that an individual with an intellectual disability diagnosis who would be placed in one severity category on the basis of his or her intellectual assessment scores could, in theory, be placed in a different category on the basis of his or her adaptive functioning score.

These considerations suggest that better ways of estimating the severity of intellectual disability in applied and research settings would be of benefit. The application of Mokken scaling methods is potentially useful for this purpose because it allows an assessment of the extent to which the items in a scale form a consistent hierarchy. Briefly, Mokken scaling is a nonparametric scaling technique that investigates the relations between items and a latent trait (Watson et al., 2012). The Mokken model with which the present study is concerned is the double monotone model (DMM). The DMM is characterized by the assumptions of unidimensionality, local independence, monotonicity, and nonintersection of item characteristic curves. If these assumptions hold for a dichotomous scale, then invariant item ordering can be inferred (Sijtsma, Meijer, & van der Ark, 2011; also see Ligtoet, van der Ark, te Marvelde, & Sijtsma, 2010, for a discussion of invariant item ordering in polytomous scales). Thus, for example, if an individual with an intellectual disability is able to carry out a given task on an assessment of his or her functioning, this would suggest that he or she would also be able to carry out all other tasks that the Mokken analysis had shown to rank below this item in difficulty. The advantage of this method is that when items form a consistent ordering in this way, single items and not just total scale scores convey useful information about a person's level on a trait (Watson, Deary, & Austin, 2007).

Mokken scaling has been found to be useful in indicating the order in which abilities are lost in those with a physical disability (e.g., Kempen, Myers, & Powell, 1995) and in older adulthood (Kingston et al., 2012). The latter authors argued that when abilities can be consistently ordered, knowledge of this ordering can assist in effective targeting of resources. This principle would be equally applicable in intellectual disability services, and it was, therefore, our aim in the present study to apply these methods to a learning disability screening tool: the Learning Disability Screening Questionnaire (LDSQ). If the LDSQ items were found to have a consistent ordering across individuals in terms of whether they were achieved, this would provide an indication of the likely performance of that person on other items of the screening tools, on the basis of his or her performance on a given item.

The LDSQ is a brief screening tool for intellectual disability (McKenzie & Paxton, 2006). It is a seven-item, dichotomously scored questionnaire asking about the ability of an individual to carry out a range of tasks that may be difficult for a person with an intellectual disability. It has the advantage over abbreviated full and intellectual assessments of not requiring the administrator to have particular professional qualifications or training, meaning that it can be used by a range of professionals. To date, screening tools have not generally been used to give an indication of the severity of an intellectual disability, only its presence or absence. In this context, it is useful to consider whether there are alternative ways of estimating the severity of intellectual disability that are based on screening tools such as the LDSQ.

Method

Measure

The LDSQ is a unidimensional scale for use with adults 16 years of age and older and is designed to identify those who are likely to have an intellectual disability. Items ask the rater to indicate whether an individual is able to complete a specified task assumed to be indicative of possible intellectual disability when beyond the capability of the individual being assessed. It comprises seven items covering areas such as literacy, independent living, contact with specialist services, schooling, and employment and was designed to be used by a range of staff without the need for a particular qualification or training. Items are scored dichotomously; that is, an individual is assumed to be either able to complete a specified task or unable to complete a specified task. The scale has been found to have good interrater reliability as well as convergent and discriminative validity, and it has a sensitivity value of 91% and a specificity value of 87% (see McKenzie & Paxton, 2006, for details).

Participants

The study used pre-existing, unidentifiable data that had been collected with prior ethical consent from the participating health boards. Of those with an intellectual disability ($n = 215$), 133 were male and 82 were female. Their mean age was 34.4 years ($SD = 14.1$) and mean FSIQ was 62.1 ($SD = 12.5$). Of those without an intellectual disability ($n = 40$), 28 were male and 12 were female. Their mean age was 28.4 years ($SD = 12.1$) and mean FSIQ was 77.9 ($SD = 6.9$). Data were originally gathered from a number of sources: most were from individuals who had been referred to two community intellectual disability services ($n = 161$), and the rest were from a community intellectual disability forensic service, a forensic in-patient secure unit, and a prison ($n = 94$). The former services were based in Scotland, whereas the prison was in England. Data were gathered from case files and from information provided by clinical psychology staff. All of the participants for whom data were collected were White and British. For further details on the data set, see McKenzie and Paxton (2006)

and McKenzie, Michie, Murray, and Hales (2012). Participants with missing data on one or more items of the LDSQ were omitted and analyses were conducted on the remaining 153 complete cases.

Statistical Procedure

The fit of the DMM to the LDSQ was investigated by examining its four assumptions—scale unidimensionality, local independence, latent monotonicity, and nonintersection— using the mokken package in R (Van der Ark, 2007). These assumptions were collectively tested by examination of scalability coefficients, manifest monotonicity, and $P(++)$ and $P(--)$ matrices.

Scalability and reliability coefficients.

It is possible to compute item, item–pair, and scale total scalability coefficients. In all cases, higher scalability coefficients are desirable. Item scalability coefficients express item discrimination and degree of relation between the item and the latent trait. It is recommended that these all be above 0.3 for items belonging to the same Mokken scale (Sijtsma et al., 2011; Sijtsma & Molenaar, 2002). Item–pair scalability coefficients express the joint scalability of item pairs. If the assumptions of the DMM hold, then these should all fall between 0 and 1. Scale scalability coefficients pertain to the entire scale and express the strength of the scale as a whole. Coefficients between 0.3 and 0.4 are indicative of a weak scale, those falling between 0.4 and 0.5 are indicative of a moderate scale, and those above 0.5 are indicative of a strong scale (Mokken, 1971). In addition, test score reliability was estimated using the rho coefficient, which is an unbiased estimator of test score reliability when the DMM holds (Van der Ark, 2012).

Latent monotonicity.

Tests of latent monotonicity are based on the fact that, for dichotomous items, latent monotonicity implies manifest monotonicity (Junker & Sijtsma, 2000). The mokken package provides information on the number and location of violations of manifest monotonicity. Monotonicity is violated whenever an item step response function fails to be nondecreasing with the latent trait; however, to avoid trivially small violations causing the rejection of the model, only those above a given size are considered (Van der Ark, 2007). For the present analyses, we adopted the program default minimum violation of 0.03.

Non-intersection.

We assessed the non-intersection assumption using the pmatrix method. This involves checking for violations of non-intersection in the matrices of the proportions of relative positive responses $P(++)$ and of relative negative responses ($P--$) to pairs of items. If non-intersection holds, then $P(++)$ should have non-decreasing entries across both columns and rows, and $P--$ should have non-increasing entries across both columns and rows.

Results

Item scalability coefficients were all above 0.3 and all item-pair coefficients were between 0 and 1, suggesting that all items of the LDSQ belong in the same Mokken scale. No significant violations of manifest monotonicity (violations exceeding 0.03) were detected, implying that the latent monotonicity assumption held. There were, however, seven significant violations of non-intersection involving the items that asked about reading, writing, employment, and learning disability contact. When the writing item was removed, no significant violations remained and all item-pair coefficients remained between 0 and 1. The scalability coefficients for the remaining items with the writing item omitted are provided

in Table 1, ordered from least to most difficult in both the psychometric and the everyday senses. Endorsing an item indicates that the person being assessed was able to complete the task that the item refers to. For example, the least difficult item was telling the time, which 65% of the sample endorsed, indicating their ability to tell the time. The task that individuals at risk of having an intellectual disability were least likely to be able to complete was holding employment. The total scale scalability coefficient for these items was 0.50 ($SE = 0.05$), indicative of a strong scale by Mokken's (1971) criteria. The estimated test score reliability in this final scale was also high ($\rho = 0.80$). In sum, after omitting the writing item, the DMM was supported in the LDQS.

Discussion

The present analysis suggested that difficulties that are indicative of having an intellectual disability and measured by the LDSQ form a hierarchy. The difficulties at the top of the hierarchy, indicating that they are harder for individuals with an intellectual disability to achieve, are tasks such as independent living and holding employment. At the bottom of the hierarchy, indicating that they are easier for those with an intellectual disability to achieve, are tasks such as telling the time and the ability to read. Thus, if an individual has difficulties with tasks such as telling the time and reading, it is likely that he or she will also have difficulties with holding employment and independent living. Conversely, individuals who are able to live independently and hold employment are not likely to have difficulties with tasks such as reading and telling the time. The fact that these items appear to form a consistent hierarchy across individuals suggests that the additional difficulties experienced by people at risk of having an intellectual disability can be predicted from other reported difficulties. This should facilitate the optimal allocation of support and is likely to be helpful to professionals who do not have specialized knowledge of intellectual disability and to

whom the individual is unknown but who have some indication of a person's support needs within contexts such as emergency admission to hospital (Bradley & Lofchy, 2005) or on arrest (McKenzie, Michie, et al., 2012).

Both having had previous contact with intellectual disability services and receiving educational support fell in the middle of the hierarchy. This implies that many individuals who are at risk of having an intellectual disability (as indicated by endorsement of items lower in the hierarchy than these items) do not come into contact with specialist clinical or educational services until later in adolescence or adulthood if at all. Many individuals who have not come into contact with specialist educational or clinical services could, therefore, still experience functional difficulties, such as issues with independent living and maintaining employment, which evade detection by clinical or educational services. The present results suggest that difficulties with these tasks may occur even for individuals with less severe impairments than would typically lead to contact with these services.

The present analysis, as well as indicating that the LDSQ has Mokken scaling properties, serves as proof of principle for the use of Mokken scaling in intellectual disability. Often, language difficulties and socially desirable responding can make obtaining accurate information about a person's functioning through self-report a challenge. Where full information on functioning is not available, scales with Mokken properties can be used to estimate that missing information on the basis of the information that is available. It would, therefore, be of interest to extend these findings to a larger pool of items relevant to intellectual and adaptive functioning in intellectual disability.

One item in the present analysis—the ability to write—did not conform neatly to the properties of a Mokken scale. Research suggests that some adaptive skills develop and plateau

differentially in people with an intellectual disability (see Chadwick, Cuddy, Kusel, & Taylor, 2005) and that the trajectory of development may be influenced by factors such as the syndrome of the individual (Dykens, Hodapp, Ort, & Leckman, 1993). It may be that writing skills are more susceptible to such factors and so are not as predictive of the individual's likely performance on the other items of the LDSQ.

Conclusions

The present article suggested that the items of the LDSQ, with the exception of the item assessing writing skills, conform to the properties of a Mokken scale. This could prove of clinical and practical benefit to a range of professionals and non-professionals who, as part of their jobs, are likely to encounter people with an intellectual disability.

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Table 1: Item Mokken Scale Properties for *LDSQ*

Item	H_i (SE)	Item Endorsement (%)	Joint Item properties					
			1.	2.	3.	4.	5.	6.
1.Time	.75 (.05)	65	-	.77(.09)	.59(.12)	.87(.09)	.93(.07)	.63(.12)
2.Read	.51 (.07)	41	97	-	.54(.09)	.55(.10)	.57(.10)	.26(.12)
3.Contact with ID services	.45 (.06)	37	95	88	-	.51(.10)	.59(.12)	.23(.11)
4.Special education	.51 (.06)	29	99	92	91	-	.47(.09)	.31(.10)
5.Independent living	.52 (.06)	28	98.	93	91	90	-	.36(.10)
6.Employment	.45 (.06)	25	97	89	88	88	88	-
Scale Total H	.50 (.05)							

Note. Below the diagonal are the percentages of pairs of responses that are consistent with that predicted by the item hierarchy. Above the diagonal are item-pair scalability coefficients H_{ij} . Items are ordered by position in hierarchy from high to low percentage endorsement.